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1.0.1 INTRODUCTION TO RIBBED SLAB DESIGN TO BS 8110

Consider the solid slab shown below.

In general, it is seen that in solid slab a **portion** of concrete below the neutral axis remains ineffective.

This ineffective concrete does not contribute to the bending strength of the slab.

So, we can remove it.

HOW?

1.0.2 PRESENTATION OF RIBBED FLOOR PLAN

- Identify l_y and l_x
- Determine the direction of span. (Load will always choose the shortest path to supports)
- Place the ribs on the plan as shown below

- The supporting beams will be of two types namely:
  - Main supporting beams
  - Secondary supporting beams

1.0.3 ADVANTAGES AND DISADVANTAGES OF RIBBED SLABS

ADVANTAGES

- Longer spans with heavy loads (12-15m)
- Reduction in dead loads due to voids
- Electrical and mechanical installations can be placed between voids
- Good resistance to vibrations

DISADVANTAGE

- Only moderate and uniformly distributed load can be accommodated

1.0.4 SIZING OF SLAB AND RIBS

CONCRETE FLANGE/ SLAB

The thickness of the concrete slab or topping should not be less than

- 30mm for slab with permanent blocks contributing to structural strength and where there is a clear distance between ribs not more than 500mm.
- 25mm when blocks mentioned in (1) are jointed with a cement-sand mortar.
- 40mm or 1/10th of the clear distance between ribs, whichever is greater, for all other slabs with permanent blocks.
- 50mm or 1/10th of the clear distance between ribs, whichever is greater, for slabs without permanent blocks.

Reinforcement in topping or slab shall constitute of a wire mesh.

RIBS

The rib width will be governed by Tables 3.2, 3.3, 3.4 & figure 3.2 of BS 8110: Part 1: 1997

Ribs' spacing should be less or equal to 1.5m and their depth below the flange should not be greater than four times their width.

1.0.5 DESIGN METHODOLOGY

When designing one way spanning ribbed slabs the following steps shall be followed:

Step 1: Dead load calculations

This will include the self-weight of the slabs and ribs.

Characteristic superimposed loads due to screed, tiles etc. should be included. If no value is given, then assume CSP as 1.0 kPa.

Step 2: Live Load calculations

The live load might not be given in calculations. Use the necessary code of practice (BS 6399)

Step 3: Ultimate design loads

The ultimate design load is calculated from:

'@ULS , n = 1.4 Dead load + 1.6 Live load

Step 4: Design data

Before proceeding with calculations of moments, it is imperative to list down all known design data: strength of concrete, strength of steel used, assumed diameter of main steel, cover

Effective depth shall be calculated.

Step 5: Bending moment at mid-span

The bending moment at mid-span shall be calculated using formulae or using coefficients in BS 8110.

Step 6: Calculation of reinforcing steel at mid-span (Design as T-section)

Once M is calculated, then the following parameters need to be calculated:

K, z = 0.95d (maximum), A_s and $A_{s\ min}$

Step 7: Bending moment at support if beam is continuous

The bending moment at mid-span shall be calculated using formulae or using coefficients in BS 8110.

Step 8: Calculation of reinforcing steel at mid-span (Design as rectangular section)

Once M is calculated, then the following parameters need to be calculated:

K, z = 0.95d (maximum), A_s and $A_{s\ min}$

Step 9: Deflection check

At mid-span, Service stress f_s need to be calculated.

M/bd^2, Modification ratio, Basic l/d shall be known, Permissible l/d calculated and Actual l/d calculated.

For deflection criteria to be satisfied, the permissible l/d ratio shall be greater than the actual l/d ratio.

Step 10: Shear Check

Maximum shear from the support center-line shall be determined and the shear stress calculated using:

Shear stress = $V/(b_r d)$ < 5Mpa or formula 8sqrt (f_{cu})

$100A_s/bd$

From table 5.1, v_c shall be determined

Step 11: Topping reinforcement

Minimum steel shall be provided in the topping = 0.13%bh

1.1 HOLLOW POT SLAB DESIGN TO BS 8110

1.1.1 INTRODUCTION

Consider the ribbed sections below:

For both types of joist systems there are two possible formworks:

- Timber formwork
- PVC/ Fibre glass formwork

Timber formwork

- If timber formwork is to be used, then a large amount shall be required
- Time is lost in the manufacture of the formworks.
- Timber formwork will not be permanent and thus on removal the resulting surfaces need to be screed.

PVC/ Fibre glass formwork or moulds

- Price of moulds is expensive (Readily available moulds may not correspond with the structural engineer's proposal. So it will have to be a special command and thus resulting price will be special too)
- Less time consuming – only placing required
- No screed since moulds are permanent.

Nowadays on site, clients always want to have cost effective solutions that reduces construction time. One such solution is to use **hollow pots to fill in the voids.**

Hollow pots are made from lightweight aggregates and have the following advantages:

- Low price
- Less time is lost – require placing only.
- The hollow pots are used as permanent formwork for ribs

The only drawback is that after removal of shuttering, the surface needs to be plastered.

1.1.2 PLACING OF HOLLOW POT BLOCKS ON SITE

1.1.3 DESIGN METHODOLOGY

All the steps mentioned above are followed with the inclusion of the self-weight of the hollow pot blocks in the dead loads.

1.1.4 LIMITATIONS

Compared to the one way spanning ribbed slab system, the hollow pots system is limited to have a clear rib span of ~450mm which is the width of a hollow block.

1.2 WAFFLE SLAB DESIGN

1.2.1 INTRODUCTION

Similar to one-way slab, it is seen that the weight of a solid two-way slab can be appreciably reduced by eliminating portions of concrete from the tensile zones without affecting the structural integrity of the the slab.

The voids are formed by the use of steel or pre-cast concrete moulds. The reinforcement for the ribs and top slab are placed in position and the concrete cast.

After curing and removal of moulds, the resulting two-way ribbed slab has a waffle like ceiling hence the name ***waffle slab***.

1.2.2 DESIGN METHODOLOGY

Steps as described in the design of one way spanning ribbed slab should be followed with the exception that moments are calculated using the formulae for restrained two-way slab.